

# International Journal of Innovative Research in Science, Engineering and Technology

(A High Impact Factor, Monthly, Peer Reviewed Journal)

Visit: [www.ijirset.com](http://www.ijirset.com)

Vol. 8, Issue 1, January 2019

## A New Methodology to Perform Big Data Analytics on Business Warehouse Data

B. Jogeswara Rao <sup>1</sup>, Prof.M.S.Prasad babu <sup>2</sup>, Dr.S.Hanumanth Sastry<sup>3</sup>

Research Scholar, Dept. of CS&SE, Andhra University, India<sup>1</sup>

Professor, Dept. of CS&SE, Andhra University, India.<sup>2</sup>

IT Manager, ERP, Visakhapatnam Steel Plant, Visakhapatnam, India<sup>3</sup>

**ABSTRACT:** The volume and variety of data stored and processed in business warehouses is growing rapidly thereby posing new challenges in data staging and its efficient retrieval for data visualisation by analytic applications. The functional layers of a business warehouse are classified into data staging, extract-transform-data loading into target infocubes and data visualization. In BI dashboards we display key metrics on material, finance, production, sales and human resource functions using warehouse data to monitor enterprise performance. Primitive business warehouse implementations such as SAP BI are unable to provide these big data processing capabilities because of the inherent limitations of the warehouse architecture. Upgrading or migrating to new BI products requires resolving many commercial and integration issues. In this paper the authors have presented a new methodology to provide dashboard reporting capabilities to the existing SAP Business warehouse by utilizing open source BIRT tools. This methodology is implemented on SAP Business warehouse for staging data and also to present key performance metrics in an enterprise dashboard.

**KEYWORDS:** Business Warehouse; Eclipse BIRT Tool; MySQL Server; Data Visualization; Dashboard Reports; Mobile Application; Tomcat; ETL

### I. INTRODUCTION

Business warehouse is a collection of integrated, subject-oriented databases that support decision making and where each unit of data is relevant to some moment of time. The warehouse also provides a set of tools to query, analyse and present information in a scalable form, persistently over a period of time. The key properties of warehouse are [1]:

1. Read only access: End users have read-only access, meaning that the data is loaded into business warehouse via Extraction, Transformation and Loading (ETL) process.
2. Cross-organizational focus: Warehouse data is sourced from all the business functions of organization such as production, sales and distribution, controlling etc.
3. Historization: Data is stored by time on a long-term basis for efficient query processing. The technical environment and data structures are optimized for answering business questions or queries but not suited for transaction processing.
4. Analytic tool: Users can use variety of analytic tools to access warehouse data. These analytic tools usually offer a user friendly interface to simplify query creation.

Analytics is an interactive process where we start with a hypothesis, explore and try to understand the data, try some different data mining model, drill down on various dimensions [2]. Business Intelligence (BI) and other analytic tools use the information assets of business warehouse to improve business outcomes, customer relationships, and

# International Journal of Innovative Research in Science, Engineering and Technology

(A High Impact Factor, Monthly, Peer Reviewed Journal)

Visit: [www.ijirset.com](http://www.ijirset.com)

Vol. 8, Issue 1, January 2019

operational efficiency. The BI system helps in discovering business critical relationships in the data and automatically builds visualizations and dashboards. Business intelligence dashboard is a BI software interface that provides preconfigured or customer defined metrics, statistics, insights and visualization into current data. BI dashboard is the foundation to obtain data driven insights and an overall view of the business performance for all business users [3].

Semantic searches can be performed on BI dashboard reports by using data filters, drill-down features and drop-down lists. This functionality should be available for both summarized and detailed data by giving due importance to the security of information provided in BI reports [4]. BI implementations should have role-based security where system authenticated users can create, edit, publish and administer the BI solution.

Enterprises that have deployed SAP BI server along with Bex tools suite are unable to add BI dashboard reporting functionality and are often driven to choose disparate analytic products offered by various BI tool vendors [5]. Also the IT roadmap for integration or migration to these BI tools for analytical needs requires resolving many technical complexities such as master data management [6], development of plug-ins, data staging, application response times (throughput), correlating or passing parameter values and the ability to derive performance metrics that involves performing complex calculations [7].

To overcome the limitations of existing SAP BI framework, authors have presented a new methodology that provides BI dashboard reporting capabilities. Here we used open source MySQL for data staging, Eclipse BIRT tools for ETL and report development, Tomcat application server to deploy web application and to provide web access to users. The rest of this paper is organised as follows: Section 2 describes recent work related to BI dashboards, Section 3 presents the architecture details of proposed methodology, Section 4 presents implementation details, Section 5 presents results and discussion on the proposed methodology and finally the conclusions are drawn in Section 6.

## II. RELATED WORK

Xing-jie et al. [8] opined that BI commits itself to technology service and decision making support by using improved ETL tools, Data Warehouse technologies and Online Analysis Process (OLAP) technologies. Gartner report [9] says that by 2019 self-service analytics and BI users will produce more analysis than data scientists. It also said that data and analytics leaders must plan for fewer constraints in how analysis is done, and give more choices in how it can be used. Lim et al. [10] observed that BI and analytics is about the development of technologies, systems, practices, and applications to analyse critical business data so as to gain new insights about business and markets and achieve better operational efficiency. Chien-wen et al. [11] investigated the impact of data environment and profitability on BI implementations. Through logistic regression they concluded that OLAP and Data warehousing play an important role in the adoption of BI and data mining framework. Lian D et al. [12] studied the challenges and opportunities in smoothly connecting industrial informatics to enterprise systems for BI research. Tong G et al. [13] observed that BI deals with the collection, consolidation, analysis and information access capabilities. They mentioned that a BI solution also includes ETL, data warehouse, reporting, multidimensional analysis and data mining capabilities. Jianwen Su et al. [14] opined that traditional ETL-data warehouse-OLAP approach to BI is effective only to deal with multi-dimensional data or data cubes but not suitable for flexible analytics such as exploration with ad hoc queries or processing data changes. Richard Hull et al. [15] have proposed a new approach to business process modelling. It is based on business artefacts which are centered on a modelling framework that places data and process on an equal footing. Ee-Peng Lim et al. [16] observed that Business intelligence and analytics (BIA) deals with technologies, systems, practices and applications to analyse critical business data to gain new insights about business and markets. They observed that the new insights can be used to improve products and services and achieve better operational efficiency. Nitya et al. [17] presented four values associated with BI namely data-driven, predictive and proactive, shared accountability and inquisitive. They also advocated about data-driven decision making for business performance improvement. ChrisnaJooste et al. [18] investigated the usability of BI applications. Their research design included user observation, heuristic evaluation and a survey in a coal mining firm. Micheline Elias [19] discussed about annotations in dashboards and other visualizations and also provided some dashboard design solutions. Mirosław et al. [20] presented an evaluation method which is based on a scorecard framework and oriented towards BI systems. This project is mainly dedicated to the management of small and medium enterprises (SME). Dresner et al. [21] mentioned that Mobile BI refers to

# International Journal of Innovative Research in Science, Engineering and Technology

(A High Impact Factor, Monthly, Peer Reviewed Journal)

Visit: [www.ijirset.com](http://www.ijirset.com)

Vol. 8, Issue 1, January 2019

the display of BI data on mobile devices such as smartphones and tablets. Brenda et al. [22] proposed a BI framework for strategic sustainability information management (Sustainable BI Framework) that can be used for educational institutes. Marilex et al. [23] studied BI & Analytics (BI &A) research topics and identified some key areas such as BI & A adoption, BI&A implementation, and BI&A benefits. Sastry et al. [42] observed that choosing the right BI framework is essential for deriving optimal results from Data Mining and Knowledge Discovery initiatives.

### III. PROPOSED METHODOLOGY

The required attributes and metrics for sales dashboard application are identified along with business team and the architecture for BI dashboard is designed as below. SAP BI InfoObjects required for dashboard development are identified and the data is extracted through Excel export function from Bex Web Analyser. The proposed methodology is designed using open source software components as shown in figure 1.

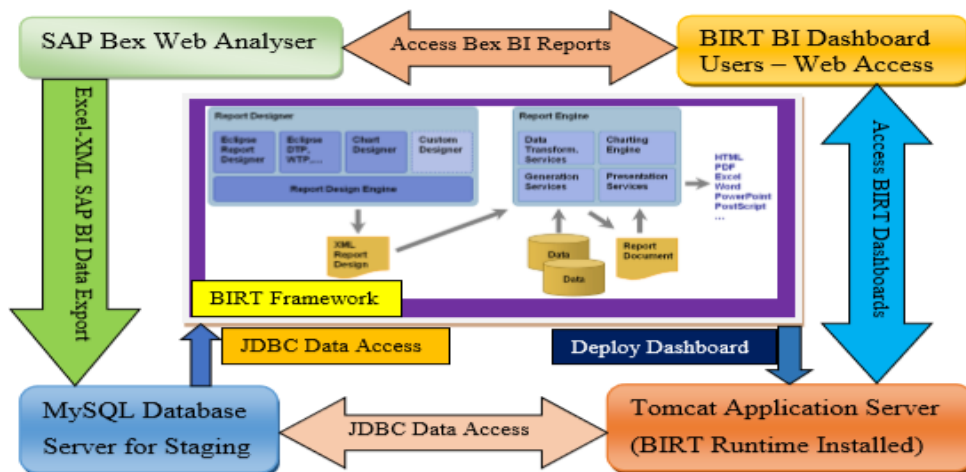


Figure 1. Architecture of BI Dashboard Application System

The software components used in the proposed methodology are briefly described here.

**SAP Bex Web Analyser:** It is a web based ad hoc analysis tool that uses output of query designer that provides access to BI Reports from several SAP applications. Choose ‘save as’ tab in browser context menu and save the generated data view as ‘excel export’. When this ad hoc analysis is saved, it saves the output of entire web application that includes the properties of web items and the layout of the data [24].

**MySQL Database:** It is an open source relational database system that uses Structured Query Language (SQL). SQL is the most popular language for adding, accessing and managing content in a database. It is useful for quick processing, proven reliability, ease and flexibility of use. MySQL server is used for a wide range of purposes, including data warehousing, e-commerce and logging applications [25].

**Tomcat Application Server:** Tomcat is an application server designed to execute Java servlets and render web pages that use java server page coding. Tomcat application server has been widely used to power a wide range of BI applications and websites [26].

## International Journal of Innovative Research in Science, Engineering and Technology

(A High Impact Factor, Monthly, Peer Reviewed Journal)

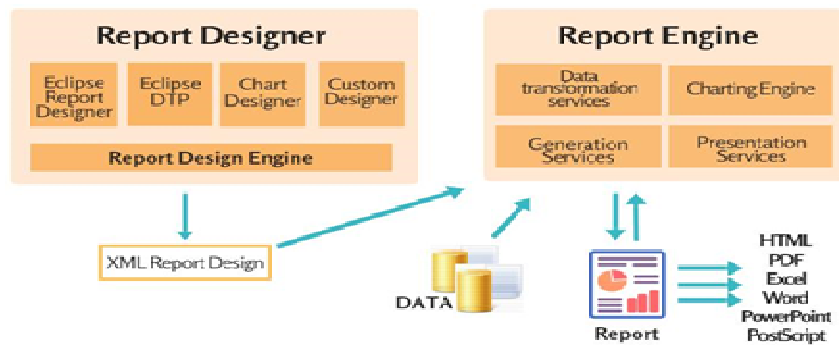
Visit: [www.ijirset.com](http://www.ijirset.com)

Vol. 8, Issue 1, January 2019

**BI User Access:** Web-based user interface has become the industry best practice due to its low cost and being effective in administration, support and deployment of it. Spring security is a J2EE-based enterprise software application that provides comprehensive security services for web applications. The two major areas of application security provided by spring security are authentication and authorization. Authentication is the process of establishing a user in the application and authorization refers to the process of deciding whether the user is allowed to perform an action within BI dashboard application [27]. BI users are both authorized and authenticated to access BI dashboard application through spring security framework.

**Big data sources:** The warehouse layer is homogenised to include data from multiple sources that are mainly casual or informal activities. The typical unstructured data formats sourced are – Emails, Spreadsheets, Text files, Documents, Portable Document Format (.PDF) files and Microsoft PowerPoint (.PPT) files.

**Business Intelligence Reporting Tool (BIRT) framework [28]:** It is an open source BI tool based on Eclipse platform which has emerged as the industry standard for BI development. It can create textual documents, crosstabs, standard pie and bar graphs. It can also tackle some advanced tasks such as grouping on sums, percentages of overall totals etc., and can be embedded in other web applications. Data can be imported into inbuilt javaDB or RDBMS products such as Oracle, DB2, and MongoDB through JDBC/Pool connections. Details of BIRT Architecture are shown in fig 2.



**Figure 2.**BIRT Architecture

BIRT reports are organized as a tree structure with the overall report as the root. BIRT provides separate categories for styles, report content, data sources, data sets, report parameters etc. BIRT resource explorer view is used to browse the contents of report libraries and also to reuse report objects such as tables, data sources and styles [29]. This view lists all libraries within the resource folder and other shared content such as images and javascript files. BIRT expression builder is used for assigning data values to report elements, building image locations, hyperlinks, default values for parameters etc. The key components of BIRT framework shown in fig 2 are briefly described below.

**BIRT Report Designer:** It is an eclipse perspective used for creating BIRT report designs that are stored in an open XML format. BIRT navigator shows projects and files that are in workspace for creation of projects, designs, and other BIRT files. Layout editor provides drag & drop creation for the presentation portion of report. Palette contains the standard BIRT report elements such as labels, tables, and charts that can be used in conjunction with layout view. Property editor presents the most commonly used properties in a convenient format. BIRT viewer allows previewing reports within eclipse. Web output is provided as a HTML document, paginated HTML, PDF, XLS, DOC, PPT and Postscript [30].

# International Journal of Innovative Research in Science, Engineering and Technology

(A High Impact Factor, Monthly, Peer Reviewed Journal)

Visit: [www.ijirset.com](http://www.ijirset.com)

Vol. 8, Issue 1, January 2019

**Report Engine:** It uses the report design files to generate and render reports. Report Engine API (RE API) allows embedding the engine in any java application. The BIRT Web Viewer uses this API to execute and display BI reports [31].

**Design Engine:** It is used for creating and modifying report designs. Design Engine API (DE API) wraps the functionality of the design engine that can be used within any java project.

**Charting Engine:** It is used to design and generate charts. Charting Engine API (CE API) allows java developers to create charts for applications. The Design Engine and Report Engine make use of this CE API to process and publish charts. Adding Charts to BIRT designs is performed using chart builder.

**Data Explorer:** It organizes data sources (connections) and data sets (queries). The data set editor is used to test the data set and to ensure that the report receives the correct data. Within this view multidimensional cubes are created using existing data sets [32]. This view is also used to design dynamic cross tables and report parameters

**Script Editor:** Scripting adds business logic to BI reports during data access, report generation or viewing [33]. The code editor is used for editing scripts such as syntax colouring, auto-complete. BIRT can also debug scripts while the report is running.

## IMPLEMENTATION DETAILS:

The implementation methodology to provide dashboard reporting capabilities to the existing SAP business warehouse is explained in the following steps.

**Step 1.** Export data using Bex Web Analyser tool: Required metrics, dimensions and attributes are identified in Bex Query designer. Bex BI report which has required attributes is executed on web browser for the selected characteristics, key figures and dimensional attributes. The Excel output of this executed Bex report is used as data source in this methodology. MySql database plug-in is installed on Excel and the data is exported or appended into database tables as shown in fig 3 [34].

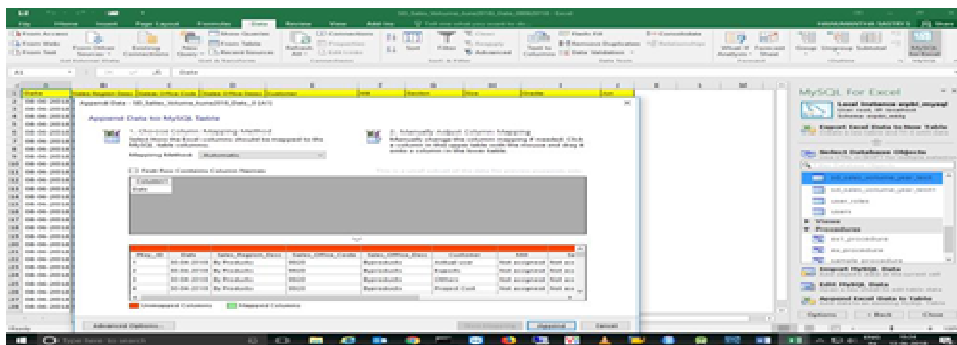


Figure 3. Excel Data export into MySQL database table

**Step 2.** Data cleansing: SQL procedures can be implemented to homogenize data and fill missing attributes or update relevant fields for multidimensional analysis [35]. The procedure shown in fig 4 below updates sales region, if found missing in source data.

# International Journal of Innovative Research in Science, Engineering and Technology

(A High Impact Factor, Monthly, Peer Reviewed Journal)

Visit: [www.ijirset.com](http://www.ijirset.com)

Vol. 8, Issue 1, January 2019

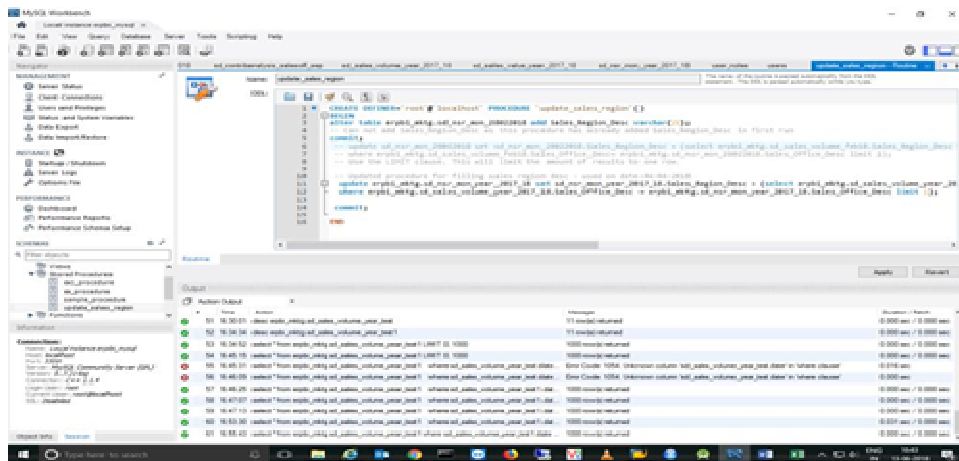


Figure 4. SQL procedure to homogenise data in tables

**Step 3** spring security framework: The following java classes and jsp pages are implemented for BI dashboard Application [36].

- 1) Application.java: This runs Spring Boot Application by implementing main methods.
- 2) MvcConfig.java: JDBC parameters for MySQL database connectivity are passed for specific schema object.
- 3) WebSecurityConfig.java: User credentials are authenticated to grant access to BI dashboard application.
- 4) login.jsp: Validates username & password and authenticates BI user's credentials.
- 5) home.jsp: Authenticated users are granted access to BIRT BI dashboard
- 6) nologin.jsp: Access denied page is displayed for invalid or unauthenticated users.

**Step 4.** BIRT Implementation: The following steps are performed for report development.

- 1) Data Sources: JDBC parameters for MYSQL dataSource are defined and the connection is established [37].
- 2) Data Sets: SQL query is defined by using tables or procedures from MYSQL database. Necessary filters are applied on data and query results are previewed.
- 3) Data Cubes: They are designed by selecting relevant datasets from above step (query definition). Semantically linked attributes, dimensions and metrics are grouped together from available data sets to form hierarchies and summary fields.
- 4) Report Parameters: Properties of BI report parameters are defined here. The selection may include report run date, sales region, sales office, product types etc.
- 5) Variables: Required BI report or page variables are defined and linked to data set.

**Step 5.** Deployment to Tomcat Application Server: BIRT runtime is installed on Tomcat Application Server and BIRT BI dashboard application is deployed. BIRT runtime components are installed in birt folder under webapps directory of tomcat [38].

**Step 6.** BI User Access: Spring security authenticated users can access BIRT BI dashboard reports using any web browser such as IE, Chrome, and Firefox etc.

## IV. RESULTS AND DISCUSSION

BIRT BI dashboard is designed to allow users to receive instant visualization of their preferred BI operations by eliminating manual execution of queries or processes. BI dashboard's appearance and interface may be customized for desktop, mobile for web or cloud users. For this BI dashboard implementation, the authors have used SAP business

## International Journal of Innovative Research in Science, Engineering and Technology

(A High Impact Factor, Monthly, Peer Reviewed Journal)

Visit: [www.ijirset.com](http://www.ijirset.com)

Vol. 8, Issue 1, January 2019

warehouse data of a steel plant. Eclipse Oxygen version is used for BIRT BI report development and deployed on Apache Tomcat application server version 9.0 that is further connected to MYSQL database server version 5.7.21. Study on Eclipse BIRT plugins developed for SAP BW connectivity has shown that YASH Technologies has provided some plug-ins to connect SAP BW with Eclipse BIRT [39]. This plug-in allows BIRT report designers to connect and access SAP Infocubes. It is observed that master data (MDM) could not be imported from SAP BW as per data modelling requirements.

Sales performance dashboard [40] is designed to provide country wide key metrics on: 1) Sales volume 2) Sales value 3) Net Sales Realization (NSR) 4) Contribution analysis. The attributes analysed in sales BI dashboard are – 1) Geographical hierarchy - Country, Region and City wise 2) Steel mill hierarchy- Mill Name, Section, Size and Grade 3) Customer segmentation – Actual, Dealers, Project and Others 4) Cross selection of any of the available attributes. The functional details of BI dashboard are given in the following figures [41] [42].

**5.1.) Login to Sales Dashboard BI Application:** Authenticated users can login and select report run date as input parameter. The details are given in fig no's 5,6 and 7.

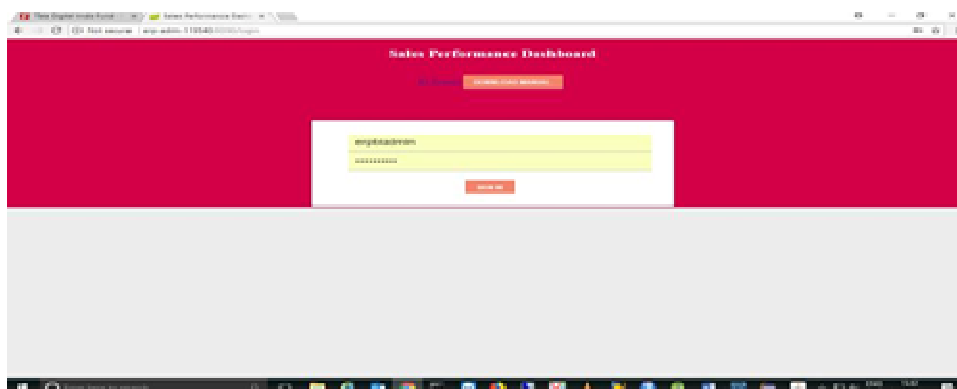


Figure 5.Login screen for BI Sales Dashboard

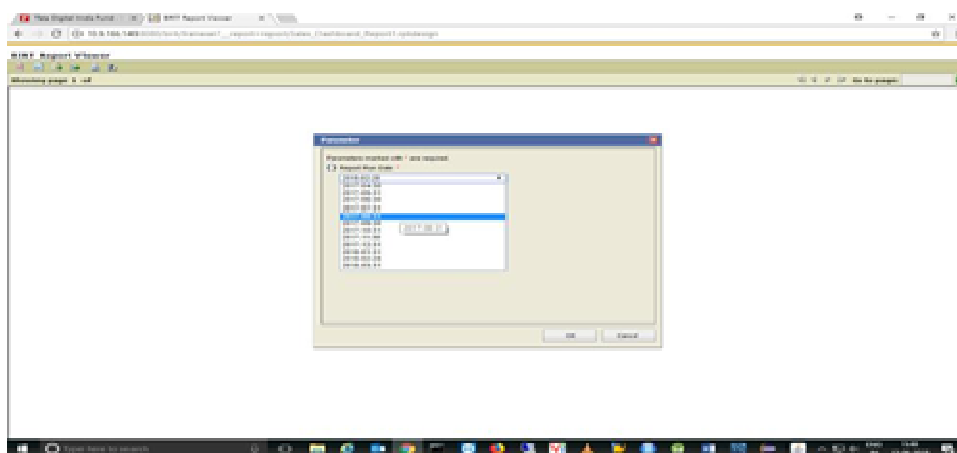


Figure 6. BI Dashboard - Select Report Run Date

# International Journal of Innovative Research in Science, Engineering and Technology

(A High Impact Factor, Monthly, Peer Reviewed Journal)

Visit: [www.ijirset.com](http://www.ijirset.com)

Vol. 8, Issue 1, January 2019

5.2.) **Initial layout:** It is split into four parts and takes report run date as input value.

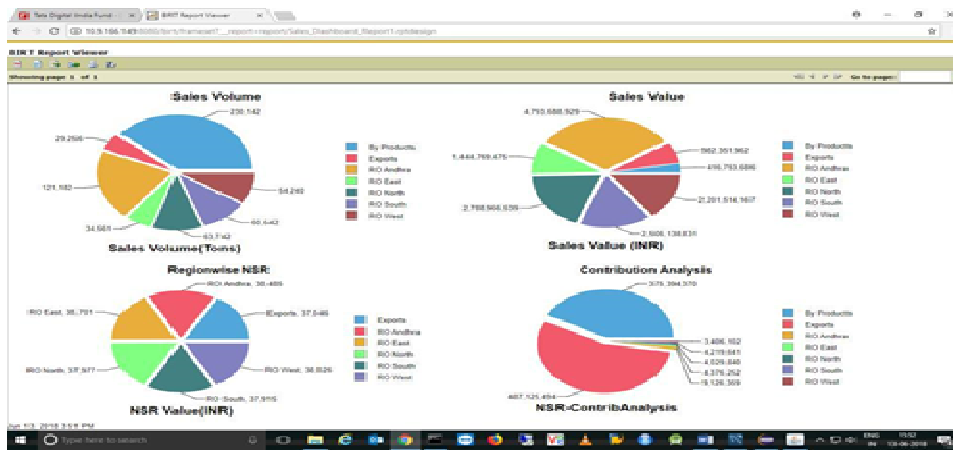


Figure 7. Sales Performance Dashboard- Initial Layout

5.3.) **Drill-down by sales region:** Sales value and volume data can be viewed for each region in fig no. 8. Steel mill wise breakup on sales metrics can also be seen here.

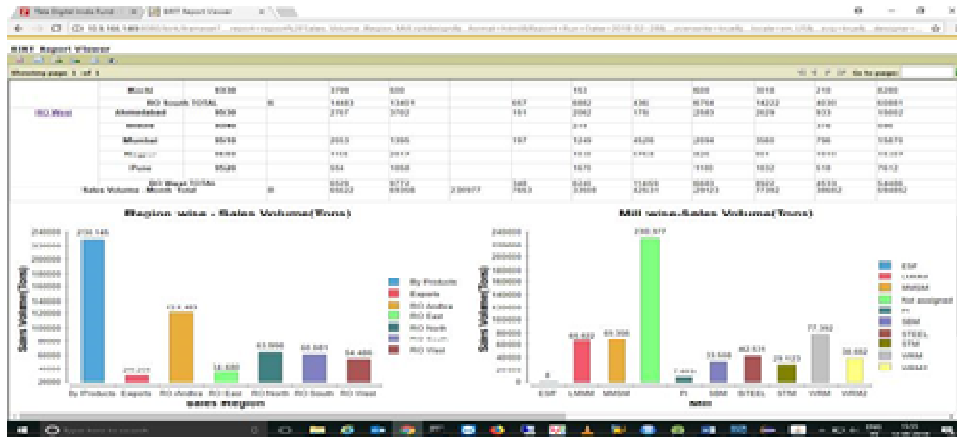


Figure 8. BI Dashboard: Drill down by Sales Region

5.4.) **Drill-down by city:** From each level roll-up to next higher level (one-step backwards) or roll-up to the starting point of the BI report, by passing relevant parameters for roll-up and drill-down OLAP operations as shown in fig no's 9 & 10.



# International Journal of Innovative Research in Science, Engineering and Technology

(A High Impact Factor, Monthly, Peer Reviewed Journal)

Visit: [www.ijirset.com](http://www.ijirset.com)

Vol. 8, Issue 1, January 2019

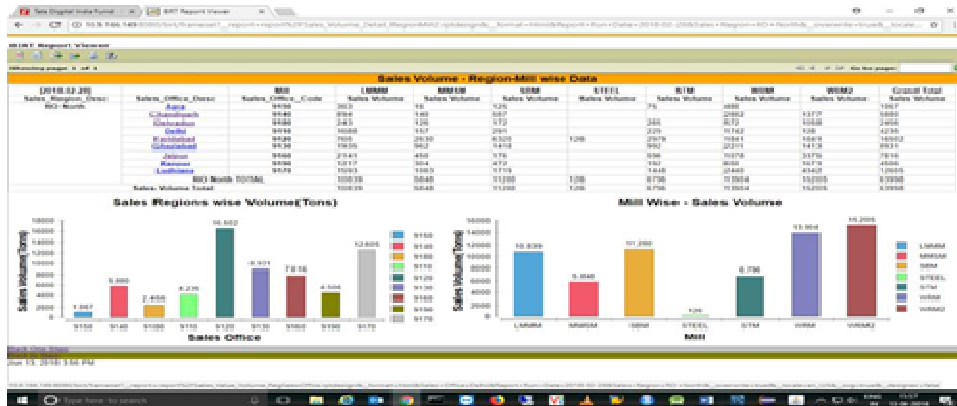


Figure 9. Sales volume – Region, Sales Office, Mill

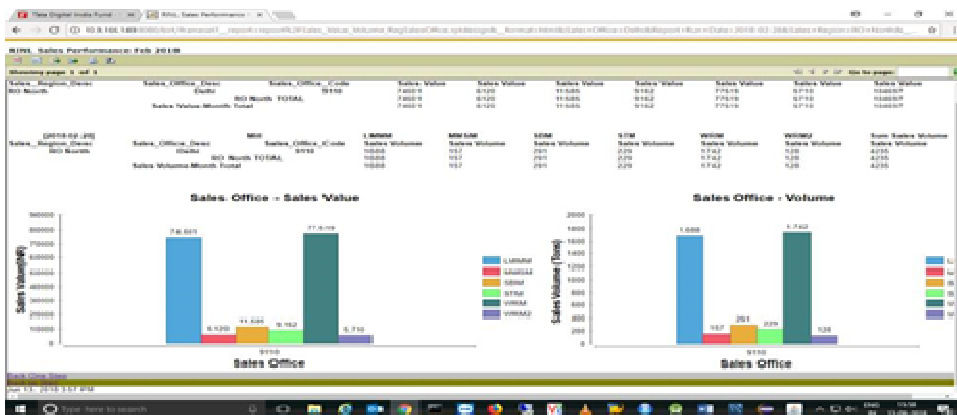


Figure 10. Sales office wise - Sales value and volume

5.5.) **NSR Reports:** NSR value for each customer segment, Steel Mill, Region and Sales office wise details are shown in the figures 11, 12 and 13 respectively.

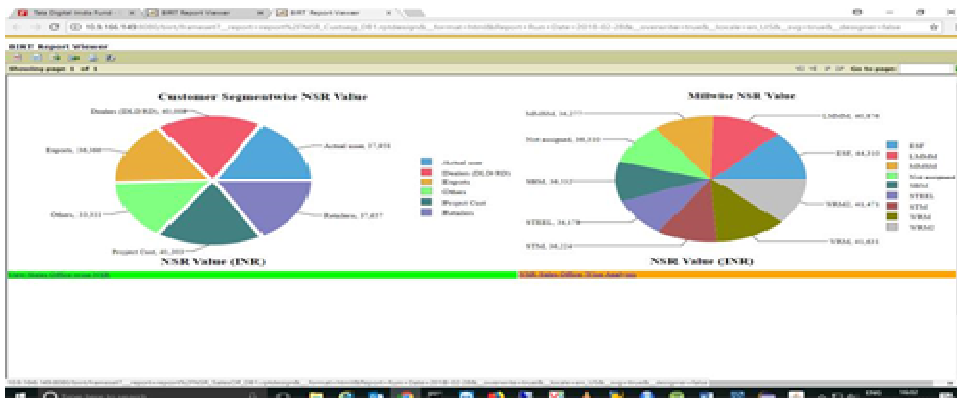


Figure 11. NSR – Customer segment and Mill wise details



# International Journal of Innovative Research in Science, Engineering and Technology

(A High Impact Factor, Monthly, Peer Reviewed Journal)

Visit: [www.ijirset.com](http://www.ijirset.com)

Vol. 8, Issue 1, January 2019

provide event triggered notifications and workflow type indicators on key performance metrics by classifying big data in business warehouse.

We have implemented an automatic text detection technique from an image for In painting. Our algorithm successfully detects the text region from the image which consists of mixed text-picture-graphic regions. We have applied our algorithm on many images and found that it successfully detect the text region.

## REFERENCES

1. Rouse, M., (2018) 'A guide to self-service business intelligence implementation' [online] <http://searchbusinessanalytics.techtarget.com/essentialguide/DIY-BI-A-guide-to-self-service-business-intelligence-implementation> (Accessed July 2018).
2. Dr. Hanumanth Sastry, S., and Prof Prasad Babu, M.S., (2018) 'Big Data and Predictive Analytics to ERP System', International Journal for Research in Applied Science & Engineering Technology (IJRASET), Vol. 6 No. 2, pp. 876- 892.
3. The BI software selection process. [online] <https://bi-survey.com/bi-software-selection-process> (Accessed 10 August 2018).
4. Huang Lei, Huang Yifei and Guo Yi. (2015) 'The research of business intelligence system based on data mining', Proceedings of the International Conference on Logistics, Informatics and Service Sciences (LISS), Barcelona, Spain, pp. 1-5.
5. Martin A., Miranda L.T., and Prasanna v., (2014) 'A survey on recent research in business intelligence', Journal of Enterprise Information Management, Vol. 27 No. 6, pp. 831-866.
6. ShimaaOuf and Mona Nasr (2011) 'Business Intelligence in the Cloud', Proceedings of the IEEE 3rd International Conference on Communication Software and Networks, Xi'an, China, pp. 650-655.
7. Benjamin Fabian and Tom Göthling (2015), 'Privacy-preserving data warehousing', International Journal of Business Intelligence and Data Mining, Vol.10, No. 4, pp.297-336.
8. Xing-jie Feng and Qi Pan (2009), 'The Design and Analysis of QAR Data Warehouse on the Subject of Flight Phase', Proceedings of the Information Engineering and Computer Science 2009, Wuhan, China, pp.1-4.
9. Analytics and BI Strategy [online] <https://www.gartner.com/doc/3869863/predicts--analytics-bi-strategy> (Accessed 26 August 2018).
10. Lim, EePeng, Chen, Hsinchun, Chen and Guoqing., (2013) 'Business Intelligence and Analytics: Research Directions', ACM Transactions on Management Information Systems, Vol. 3 No. 4, pp. 1-10.
11. Chien-wen Shen, Ping-Yu Hsu and Yen-Ting Peng (2012), 'The impact of data environment and profitability on business intelligence adoption', Proceedings of the 4th Asian Conference on Intelligent Information and Database Systems (ACIIDS), Kaohsiung, Taiwan, pp. 185-193.
12. LianDuan and Li Da Xu (2012) 'Business Intelligence for Enterprise Systems: A Survey', IEEE Transactions on Industrial Informatics, Vol. 8 No. 3, pp. 679-687.
13. Tong Gang, Cui Kai and Song Bei (2008) 'The research & application of Business Intelligence system in retail industry', Proceedings of the IEEE International Conference on Automation and Logistics, Qingdao, China, pp. 87-91.
14. Jianwen Su and Yan Tang (2017) 'Business Intelligence Revisited', Proceedings of the Fifth International Conference on Advanced Cloud and Big Data (CBD), Shanghai, China, pp. 1-6.
15. Richard Hull, Jianwen Su and Roman Vaculin., (2013) Proceedings of the 2013 ACM SIGMOD International Conference on Management of Data, New York, USA, pp. 943-948.
16. Ee-Peng Lim, Hsinchun Chen and Guoqing Chen. (2013) 'Business Intelligence and Analytics: Research Directions', ACM Transactions on Management Information Systems (TMIS) Vol. 3 No. 4, article no. 17, pp. 1-12.
17. NityaVerma and Amy Voida., (2016) 'Mythologies of Business Intelligence', Proceedings of the 2016 CHI Conference Extended Abstracts on Human Factors in Computing Systems, California, USA, pp. 2341-2347.
18. ChrisnaJooste, Judy van Biljon and Jan Mentz (2013) 'Usability evaluation guidelines for business intelligence applications', Proceedings of the South African Institute for Computer Scientists and Information Technologists Conference, East London, South Africa, pp. 331-340.
19. Micheline Elias. (2012) 'Annotating BI visualization dashboards: Needs & Challenges', Proceedings of the SIGCHI Conference on Human Factors in Computing Systems, Texas, USA, pp. 1641-1650.
20. MirosławDyczkowski, Jerzy Korczak and Helena Dudycz (2014), 'Multi-criteria evaluation of the intelligent dashboard for SME managers based on scorecard framework', Proceedings of the 2014 Federated Conference on Computer Science and Information Systems, Warsaw, Poland, pp. 1147-1155.
21. H.Dresner, 'Mobile Business Intelligence Market Study' [online] [www.mobile-bi.study.com](http://www.mobile-bi.study.com) (Accessed 24 August 2018).
22. Brenda Scholtz, Andre Calitz and Ross Haupt. (2018) 'A business intelligence framework for sustainability information management in higher education', International Journal of Sustainability in Higher Education, Vol. 19 No. 2, pp.266-290
23. Marilex Rea Llave (2017), 'Business Intelligence and Analytics in Small and Medium-sized Enterprises: A Systematic Literature Review', Proceedings of the International conference on Project Management, Barcelona, Spain, pp. 194-205.
24. SAP Netweaver 7.3 EHP1. [online] [https://help.sap.com/saphelp\\_nw73ehp1/](https://help.sap.com/saphelp_nw73ehp1/) (Accessed 20 August 2018).
25. Analytics and Reporting using SQL. [online] <https://www.sisense.com/data-connectors/mysql/> (Accessed 12 August 2018).
26. King Tin Lam, Yang Luo and Cho-Li Wang (2008), 'A Performance Study of Clustering Web Application Servers with Distributed JVM', Proceedings of the 14th IEEE International Conference on Parallel and Distributed Systems, Melbourne, Australia, pp. 328-335.
27. RasmeyHeang and Raghul Mohan. (2018), 'Literature Review of Business Intelligence', [online] <http://www.diva-portal.org/smash/get/diva2:1080911/FULLTEXT01.pdf> (Accessed July 2018).
28. Eclipse BIRT [online] <https://www.eclipse.org/birt/> (Accessed 5 March 2018).

## International Journal of Innovative Research in Science, Engineering and Technology

*(A High Impact Factor, Monthly, Peer Reviewed Journal)*

Visit: [www.ijirset.com](http://www.ijirset.com)

Vol. 8, Issue 1, January 2019

29. Opentext Business Intelligence, [online] <https://www.predictiveanalyticstoday.com/birt-business-intelligence/> (Accessed 10 August 2018).
30. Bondur, T., and Weathersby, J. 'BIRT: Building Next Generation BI Using Open Source. Open Source Business Resource' [online] <http://timreview.ca/article/290> (Accessed 15 August 2018)
31. Diana Peh, Nola Hague and Jane Tatchell (2011), 'BIRT A Field Guide', Addison-Wesley 3rd Edition, New York, pp. 576-630.
32. Business intelligence: Reporting [online] <http://www.open-source-guide.com/en/Solutions/Applications/Business-intelligence-reporting/Birt/> (Accessed 13 May 2018).
33. Open source BI projects to watch. [online] [https://www.cio.com.au/article/print/370451/5\\_open\\_source\\_bi\\_projects\\_watch](https://www.cio.com.au/article/print/370451/5_open_source_bi_projects_watch) (Accessed 15 June 2018).
34. Mishra B. K., Hazra D., Tarannum K. and Kumar M. (2016) 'Business Intelligence using Data Mining techniques and Business Analytics', Proceedings of the International Conference System Modeling & Advancement in Research Trends (SMART), Moradabad, India, pp. 84-89.
35. Miškuf M., Zolotová I. (2015) 'Application of business intelligence solutions on manufacturing data', Proceedings of the IEEE 13th International Symposium on Applied Machine Intelligence and Informatics (SAMII), Herl'any, Slovakia, pp. 193-197.
36. Gan Shan and Du Haoquan, (2014) 'Research on Business Intelligence Application in Electric Grid Industry Based on Data Mining', Proceedings of the 7th International Conference on Intelligent Computation Technology and Automation, Changsha, China, pp. 449-451.
37. Thomsen, E., (2002) 'OLAP Solutions: Building Multidimensional Information Systems', John Wiley & Sons, London, pp. 510-596.
38. Wrembel R., and Koncilia, C., (2007) 'Data Warehouse and OLAP: Concepts in Architectures and Solutions', IRM Press, California, pp. 167-256.
39. YASH SAP BW Connector, <https://www.yash.com/technology/sap/sap-solutions/business-intelligence/yash-sap-bw-connector/> (Accessed 16 July 2018).
40. Verkoou, K., Spruit Marco. (2013), 'Mobile Business Intelligence: Key Considerations for Implementations Projects', Journal of Computer Information Systems, Vol. 54 No. 1, pp. 23-33.
41. Malu Castellanos, Florian Daniel, Irene Garrigós and Jose-Norberto Mazón (2013), 'Business Intelligence and the Web', Information Systems Frontiers, Vol. 15, No. 3, pp. 307-309.
42. Hanumanth Sastry, S., and Prof. Prasad Babu M.S., (2013) 'Implementing a successful Business Intelligence for Enterprises', Journal of Global Research in Computer Science (JGRCS), Vol. 4 No. 3, pp. 55-59.